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ANTS, BEES, AND WASPS

Ants, Bees, and Wasps; a Record of Observations on the Social Hymenoptera. By Sir John Lubbock, Bart., M.P., F.R.S., D.C.L., LL.D., Pres. B.A. and L.S., &c. International Scientific Series, Vol. XL. (London: Kegan Paul, Trench, and Co., 1882.)

SIR JOHN LUBBOCK has done well to gather all the results of his serially published observations on the social hymenoptera in one treatise, and to bring out the treatise in the International Scientific Series. On the one hand the extensive and important research on which he has for so many years been engaged is thus presented to the naturalist no longer in the form of scattered papers, and on the other hand the International Scientific Series, both on account of its popularity at home, and of its well-organised machinery for securing rapid translations abroad, is the most suitable place for publishing results which are in so eminent a degree of interest to general readers.

Looking to the investigations as a whole, or in the connected form in which they are now presented, we think that they deserve to be considered the most scientifically methodical, as well as in many respects the most scientifically fruitful, which have hitherto been prosecuted in the region of comparative psychology. In saying this we do not forget the investigations of Reaumur, Huber, Forel, Darwin, Moggridge, McCook, Morgan, or Spalding—all of whom we regard as holding more substantial claims to recognition in this respect than many others who might be mentioned in the same connection. But when we compare the researches of Sir John Lubbock with those of any other comparative psychologist, we find that he has the merit of showing, if not the greatest appreciation of scientific method, at least the greatest determination in applying such method to the questions with which comparative psychology has to deal. Darwin and Spalding are the only other men who in this department of science have shown an adequate estimate of the importance of experiment as distinguished from observation; but neither Darwin nor Spalding had time to experiment in psychology on a large scale—the former having had so many other lines of inductive and deductive research to attend to, and the latter having died so young. Thus it is that when we compare the investigations of Sir John Lubbock with those of other workers in the field of animal psychology, we must assign to him the first place among these workers as a scientific observer.

For the most part the volume before us is a reprint of the papers read before the Linnean Society, with only as much re-casting as is rendered necessary to give a systematic form to the book. A few coloured plates, however, are added, as well as a brief account of some of the chief facts recorded by other observers of ants. The latter, indeed, is slender, and is not even attempted in the case of bees; so that the essay is strictly, as its title proclaims, "A record of observations on the social hymenoptera"; it is not an account of all that we know concerning the psychology of these animals. As the essay is sure to attain a wide popularity, it is perhaps to be regretted that

its author did not take the opportunity of disseminating complete information upon so interesting a subject, together with the "record" of his own "observations." But this is a matter on which opinions are likely to differ, and there can be no doubt that within the scope laid down by its title, the work is admirably arranged.

We shall now proceed briefly to enumerate the principal results which this record of observations sets forth.

The longevity of ants has been found to be much greater than was formerly supposed, for while previous observers were for the most part of the opinion that these insects die off every year, Sir John says:—

"I have now (December, 1881) two queens which have lived with me since the year 1874. They must therefore be at least seven years old, and seem still quite strong and well. I have also some workers which I have had in my nests since 1875."

The following facts and opinions on questions of morphology may be quoted:—

"I must regard the ancestral ant as having possessed a sting, and consider that the rudimentary condition of that of Formica is due to atrophy, perhaps through disuse."

Some species have the power of ejecting their poison to a considerable distance—as much as eighteen inches—and this power might have led to the sting falling into disuse, especially if the poison is, as it appears to be, "so intensified in virulence as to act through the skin."

"The question arises whether the different kinds of workers are produced from different eggs. I am disposed to agree with Westwood in the opinion 'that the inhabitants of the nest have the instinct so to modify the circumstances producing this state of imperfection, that some neuters shall exhibit characters at variance with those of the common kind.'

"Among bees and wasps the workers are occasionally fertile; but so far as our observations go, it is a curious fact that their eggs never produce females, either queens or workers, but always males. . . . It became therefore an interesting question whether the same is the case among ants, and my nests have supplied me with some facts bearing on the question."

These facts consist of numerous cases of fertile eggs having been laid by workers, and in every case with the result of producing a male insect.

With regard to psychology, we have only space to allude briefly to the more important results.

Experiments showed that certain individual ants in a community "are told off as foragers, and that during winter, when little food is required, two or three are sufficient to provide it."

Observations concerning sympathy and affection went to show, that while in most cases such feelings seemed to be entirely absent, in some cases they seemed to be certainly present. This was so in an instance observed last year, of a "poor ant lying on her back, and quite unable to move." Her companions moved her tenderly, for whenever Sir John "tried uncovering the nest where she was, the other ants soon carried her into the shaded part," and when they left the nest for an airing, they carried the invalid with them.

It was previously known that all the ants in the same nest recognise one another as friends. Sir John tried chloroforming and intoxicating certain individuals, to see whether this would prevent their being so recognised.

The chloroformed ants were treated by their companions as dead, but the intoxicated ones were recognised and taken into the hive, while intoxicated strangers were rejected. The manner in which recognition is effected has long been a standing puzzle to observers, and although Sir John Lubbock has not shown "how it is done," he has at least shown very conclusively how it is *not* done. Previous hypotheses supposed the faculty to depend on recognising personal appearance, personal scent, or on there being some pass-signal understood by all the members of a hive, and not known to members of other hives. But Sir John has found that the recognition is effected when the pupæ are hatched out away from their native hive, and even when the eggs are developed in one half of a divided hive, and the matured insects then returned to the other half. He also found that the memory of companions or nest-mates extends over at least a year and nine months.

Regarding the power of communication, the experiments went to show a strange uncertainty, though they agree with previous observations in establishing the main fact that such a power exists. Thus, for instance, when a dead fly was pinned down so that the ant which found it could not drag it towards the nest, she returned to the nest and procured assistance. This experiment was repeated, with small variation, a great number of times, and certainly proves a power of communication at least to the extent of "follow me." Moreover, by an ingenious device with three parallel tape bridges extending from a nest to three similar glasses, one empty, another holding a few larvæ, and the third filled with many larvæ, Sir John was able to show the interesting fact that ants can give definite information to one another as to locality, without requiring merely to lead the way. For he took two ants and placed one of them to the glass with many larvæ, and the other to that with a few. Each of them took a larva, carried it to the nest along the respective tapes, returned for another, and so on. After each journey he put another larva in the glass with a few larvæ to replace the one which was taken away. Every new ant which came to either of the glasses was imprisoned till the end of the experiment. Such being the conditions, it was observed that no ants went along the tape bridge to the empty glass, 104 ants went to the glass with a few larvæ, and 304 to the glass with the many larvæ. Thus it seems that the two original (marked) ants were able to tell their companions, not only where larvæ were to be found, but even where the largest store was to be met with.

Concerning the powers of special sense, a large number of experiments proved that ants are able to appreciate colour, and when their nests are covered with slips of stained glass, analysis of some of these experiments showed that there had congregated "under the red 890, under the green 544, under the yellow 495, and under the violet only 5." Other experiments showed that red light was the same to them as darkness, or, at least, that about the same proportion of ants congregated under red glass as congregated under a slip of porcelain. With reference to the parts of the spectrum invisible to our eyes, other experiments proved "that the limits of vision of ants at the red end of the spectrum are approximately the same as ours, that they are not sensitive to the ultra-red rays;

but, on the other hand, that they are very sensitive to the ultra-violet rays." A layer of sulphate of quinine or of bisulphide of carbon had the effect, as might be supposed from the latter statement, of rendering the ultra-violet rays invisible, or less obnoxious to the ants. Conversely, a saturated solution of chrome alum, and chromium chloride in a layer so thick that in the darkness beneath it the ants could not be seen, had the effect of inducing the ants to escape from its luminosity to their eyes, and to go beneath the bisulphide of carbon; so that, "though to our eyes the bisulphide of carbon is absolutely transparent, while the chrome alum and chromium chloride are very dark, to the ants, on the contrary, the former appears to intercept more light than a layer of the latter."

A number of elaborate experiments on the sense of hearing produced only negative results, though from other considerations (chiefly anatomical) Sir John concludes, "On the whole, though the subject is still involved in doubt, I am disposed to think that ants perceive sounds which we cannot hear." Experiments on the sense of smell showed that the estimate previously formed by naturalists of its excellence was not exaggerated.

A number of experiments on the general intelligence of ants in overcoming difficulties of various kinds which Sir John devised for them, went to indicate a poverty of resources scarcely to have been expected; but it must be remembered that this only shows that there are ants and ants, for other trustworthy observers give wonderful accounts of the high intelligence of certain foreign species. On the subject of way-finding, there are also many interesting observations, which show that sight is not of nearly so much service as smell, although it is of much use in giving them their general "sense of direction;" for they observe the direction in which light is shining, guide themselves accordingly, and lose themselves if turned partly round on a rotating table in the dark.

We must not leave these chapters on ants without referring to one on the relation of these insects to plants, and another on their relation to animals. It is of importance to many species of plants that they should not be visited by ants, as the presence of these insects would tend to keep away bees, &c., which are required to fertilise the flowers. Consequently, these species of plants present a great variety of contrivances to exclude the ants, such as water-traps, slippery surfaces, narrow passages, sharply-curved stalks, hairs, viscid secretions, &c. Instances of such contrivances are given, and the general conclusion is stated that "though ants have not influenced the present condition of the vegetable kingdom to the same extent as bees, they have also had a very considerable effect upon it in various ways." Concerning the relation of ants to other animals, the most interesting addition to our knowledge which Sir John has made is that of *Lasius flavus* farming the eggs of aphides. For "here are aphides, not living in the ants' nests, but outside, on the leaf-stalks of plants. The eggs are laid early in October on the food-plant of the insect. They are of no direct use to the ants, yet they are not left where they are laid, exposed to the severity of the weather and to innumerable dangers, but brought into their nests by the ants, and tended by them with the utmost care through the long winter months until the following March, when the young ones are brought out and again placed on the

young shoots of the daisy. . . . Our ants may not perhaps lay up food for the winter (like the harvester), but they do more, for they keep during six months the eggs which will enable them to procure food during the following summer, a case of prudence unexampled in the animal kingdom."

Only one chapter of the book is devoted to bees, and one other to wasps. These, however, are very interesting, as the following *résumé* will show:—

Numerous observations went to prove "that bees do not bring their friends to share any treasure they have discovered so invariably as might be assumed from the statements of previous writers;" and also that in general bees are rather stupid in finding their way to honey out of rooms, &c. Their affection and sympathy is even less developed than in ants, so that Sir John doubts "whether they are in the least fond of one another." Their special senses are much the same as those of ants, hearing being to all appearance absent, while smell and sight are well developed, the latter enabling the insects to distinguish differences of colour on coloured surfaces. They prefer blue.

All these remarks apply to the experiments on wasps no less than to those on bees, except that they are somewhat more clever in finding their way, and show less preference for certain colours. One individual wasp was tamed, used to perch upon the hand, "apparently expecting to be fed," and even allowed herself to be stroked without any appearance of alarm.

We have now said as much as our space permits to recommend this work to all who take an interest in one of the most interesting branches of natural history. We can only find two points on which to offer criticism. Over a hundred pages are occupied with appendices, conveying minute details of the observations and experiments mentioned in the previous part of the work. These details appear to us unnecessary in a popular book, and we think that the space filled by them might have been more profitably devoted to a well compressed abstract of the observations of other naturalists upon the psychology of the hymenoptera.

The second point, which seems to us fairly open to criticism, is that concerning the author's views on the philosophy of vision. He discusses the theories of vision by simple and compound eyes of insects, and says, "The prevailing opinion of entomologists now is that each facet receives the impression of one pencil of rays; so that, in fact, the image formed by a compound eye is a sort of mosaic," and proceeds to observe that this theory "presents great difficulties," because "those ants which have very few facets must have an extremely imperfect vision," and also because the ants have simple eyes as well as compound, so that, according to the theory, the former cast reversed images, and the latter direct—a consideration which leads Sir John to remark, "that the same animal should see some things directly, and others reversed, and yet obtain definite conceptions of the outer world, would certainly be very remarkable."

Now, as regards the first objection, the perfection or imperfection of the vision would not necessarily be determined by the *number* of the facets any more than by their *size*. If a given area or eye-space is throughout a receptive surface, it need make no difference whether the

area is composed of a few facets or of many; the perfection or imperfection of the apparatus as an eye would in either case depend on the distinctness or definition with which a pencil of rays is admitted into each facet, whether the pencil itself be wide or narrow.

And, as regards the second objection, we can see no real difficulty in supposing that the same animal should with some of its eyes see direct images and with others reversed images, without any confusion resulting to its mental perceptions. Let us first consider the case of reversed images. Sir John Lubbock says that we "see everything really reversed, though long practice has given us the right impression." But this statement is not quite correct. We do not really *see* things reversed, for the mind is not a perpendicular object in space standing behind the retina in the manner that a photographer stands behind his camera. To the mind there is no up or down in the retina, except in so far as the retina is in relation to the external world, and this relation can only be determined, not by sight, but by touch. And if only this relation is *constant*, it can make no difference to the mind whether the images are direct, reversed, or thrown at any angle with reference to the horizon; in any case the correlation between sight and touch would be equally easy to establish, and we should always *see* things, not in the position in which they are *thrown upon* the retina, but in that which they occupy *with reference to* the retina. Thus it really requires no more "practice" correctly to interpret inverted images than it does similarly to interpret upright images, and therefore the fact that some eyes of an ant are supposed to throw direct images, while others are supposed to throw reversed, is not any real objection to the theory which Sir John Lubbock is considering.

We give these criticisms as the only ones we have found it possible to make, and heartily wish so interesting a book the success which it deserves.

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OUR BOOK SHELF

The Great Giant Arithmos, a Most Elementary Arithmetic. By Mary Steadman Aldis. (London: Macmillan, 1881.)

"THERE are still mothers who wish to retain some portion of that influence which nature intended them to have in the training of their children, and who refuse to abandon it wholly either to the schoolmaster or the state. To such as these this little book is offered as a help in laying the foundations of one of the most important branches of instruction." In fifty-eight chapters the tender student is led pleasantly, clearly, and thoroughly, from the very simplest notions which lie at the threshold of arithmetic till he (or she), having solved many of the giant's easy riddles, is in a very good position to find out for himself some of the harder ones. We should say that the child who has had this course carefully laid before it, will have had its interest maintained throughout without flagging, for the mode of presenting the subject is such as to excite attention without causing fatigue. The lessons are all short, the questions pointed, and such as to draw out what knowledge has been acquired. Very little more is done than to explain the elementary operations of numeration, addition, subtraction, multiplication, and division. Towards the close a glance is given at some of the giant's more recondite mysteries, as of parts